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ABSTRACT

This study investigated the effects of having student writers use a set of networked computers to assist them in their writing lessons. Subjects were 15 students who were designated by their school district as remedial writers because they did not pass a writing competency test in their freshman year. For 10 weeks students participated in the AT&T Learning Network and collaborated on a project with students in six other locations around the country and overseas connected by means of an electronic network. The project involved the writing and publication of a booklet about life in the various locations. Each student wrote an essay in September before work with the computer network system was begun and again in January after work with the computer network system was completed. Results were consistent with the findings of much larger studies. Findings indicated that the benefits of introducing network technologies in composition classrooms may be greatest for those students who have traditionally fared poorly in those classrooms. This new technology may be especially well suited to the elusive task of creating a more equitable educational system, one in which all students interact freely and comfortably with their teachers and peers, thereby increasing their opportunities to learn and grow. (Two figures and two tables of data are included and 15 references are attached.) (MG)

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Interactive Effects of Computer Network and Student Characteristics on Students' Writing and Collaborating

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Interactive Effects of Computer Network and Student Characteristics on Students' Writing and Collaborating

Ever since its inception, the team of microcomputer and wordprocessing program has enjoyed a comfortable alliance with writers. Computers with their wordprocessing programs facilitate the composing process, especially at the revision and editing stages. In the early years, when the study of writing was still largely the work of cognitive psychologists, computer programs that were designed to teach people how to write more effectively dealt with issues such as planning (Burns, 1984; Rodrigues & Rodrigues, 1984; Schwartz, 1982; Wresch, 1982) and revising or editing (Bean, 1983; Collier, 1983; Kiefer & Smith, 1984) in purely cognitive ways. Typically, individual writers faced with the task of beginning an essay would sit at a keyboard and terminal, using a prewriting program that would prompt them with questions designed to stimulate thorough and deep exploration of their chosen topic. Those same individuals, once they had initial drafts of their papers, would also take advantage of the editing capabilities of their word processing program to revise and edit those initial drafts. Some programs especially developed for instructional purposes would even help writers detect their spelling and grammatical errors or would provide a description of the writing in terms of its syntax or discourse features. The purpose of these text analytic devices was to assist the writer in making decisions about how to revise their essays.

More recently, however, theories about the writing process

have moved away from strictly cognitive formulations to include a more social cognitive framework for understanding how writers function (Heap, 1989; Lemke, 1989; Tierney & Rogers, 1989). The addition of the social component to the model helps to account for how writers learn to tailor their messages, their rhetorical choices, and their writing style to specific audiences. The more socially based models also help to explain how writers shape their understandings of specific topics and their written texts by listening to others speak, by reading others' writings, and by watching others respond to their own oral and written utterances. In short, language is a thoroughly social enterprise. It is learned in social contexts and it serves social purposes. And any attempt to describe the writing process must take these social dimensions of the process into full account.

In keeping with this shift from the purely cognitive to the social cognitive, recent investigations into the use of computers as writing tools have begun to emphasize the social role that computers can play, especially in classrooms (Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, and Zubrow, 1991; Heap, 1989; Levin & Boruta, 1983; Levin, Boruta, & Vasconcellos, 1983; Riel, 1983). For example, observations of children working on computers have shown how activities that traditionally are carried out by individuals often turn into more collaborative ventures, primarily because of limited access to computers. Few classrooms have enough computers for every student to have his or her own keyboard and terminal, hence children are often required to double, even triple,

up on the same machine. The investigators of one study found that while students were waiting their turn at the computer, much sharing of their hand drafted texts transpired, resulting in revisions inspired by what the other students had written in response to the same topic (Dickson & Vereen, 1983). Computers, in other words, tend to result in a reorganization of the social context of the classroom, often giving students more opportunities to interact with and learn from each other.

Another way that computers can be used to foster the social interaction that is such a part of learning to use language effectively is through what has come to be known as networks. Computers can be hooked up with other computers to facilitate communication between individuals. Some network systems will connect the students in a given classroom or school. Others will connect students in one classroom with students in other classrooms across the country and around the world. These connections encourage students to share their thinking and their writing. The social functions of language are fully operative in most network systems.

Not surprisingly, one recent investigation of the effects of computer network technologies on patterns of classroom interaction found that teachers who were connected with their students via computer networks interacted more with those students than teachers who were not so connected with their students and that students who were highly computer anxious communicated electronically with their teacher and peers less often than their peers who felt more

confident when using computers (Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, & Zubrow, 1991). More surprising than these findings, however, was the finding that teachers who were connected with their students via a computer network communicated electronically more often with less able students than with more able students. In addition, less able students also communicated electronically with other students more often than did their more able peers. In other words, the addition of a computer network into a typical composition classroom resulted in rather dramatic shifts in the typical patterns of interaction between teacher and student and between student and student, with the lower ability students having more and/or taking greater advantage of opportunities to interact with others when the computer network was available to them.

The investigators of this study speculated that use of computer networks for providing feedback to student writers, as opposed to the face to face communication typically experienced in writing conferences between teacher and student or between student and student, resulted in the delivery of fewer social cues (e.g., smiling, frowning, hesitation in the voice) regarding the quality or worth of one's writing. Since the evaluative dimension of feedback appears to be moderated with the use of the computer network, the less able writers in this study may have felt more comfortable receiving feedback through the computer network. These students, who usually receive bad news about their academic abilities in writing conferences, may also have appreciated the

anonymity and privacy of the networked conference. They could retrieve feedback messages when they felt prepared to deal with them, not when their teacher or peers felt ready to send those messages, and they could receive those messages without others scrutinizing their immediate responses. The introduction of this computer network system into typical composition classes clearly altered the social context of those composition classes.

Obviously, the computer, especially one that is networked with other computers, is a tool that facilitates the cognitive dimensions of the composing process, at the same time that it supports the more social or collaborative functions of human language, and as such it should help students learn to write better and more effectively than the more conventional mode of producing written discourse (i.e., pencil or pen and paper). The purpose of this study, therefore, was to investigate the effects of having student writers use a set of networked computers to assist them in their writing lessons. The primary hypothesis was that students who experienced the computer network system would show greater gains in the quality of their written essays over the course of a semester than would students who did not experience the computer network system and that the greatest gains would be made by students who report low levels of linguistic competence in academic contexts and students who report high levels of computer competence. Additional hypotheses were that the students experiencing the computer network, especially those reporting low levels of linguistic competence and high levels of computer

competence, would report enjoying the class more and would recall collaborating with peers more over the course of the semester than would the students not experiencing the computer network.

METHODS

Subjects

Twenty-eight students designated by their school district as being remedial writers because they did not pass a writing competency test in their freshman year participated in this study. Every other day, these students attended a special class designed to improve their writing skills. These classes were actually small groups of students (two to six at a time) meeting with a teacher to work intensively on their writing skills. Thirteen of the students in these special classes either withdrew from the class over the course of the semester or were absent on one or more of the three data collection days, leaving 15 students for whom a complete set of data was available.

Design

The students in this study were assigned to either the treatment condition (working with the computer network system) or the control condition (not working with the computer network system). While random assignment of individuals to the two conditions was not possible, the eight separate intact groups of students were randomly assigned to the treatment and control conditions. In addition to the manipulated variable, two student self-report variables were included in the design of the study. These variables were the students' self-perceived linguistic

competence in academic contexts and their self-perceived competence in using computers. The three outcome, or dependent, variables were the gains evident in the quality of student writing from the beginning to the end of the semester, the students' rating of the class, and the students' reports of collaborative behavior while writing during the semester.

Treatment

For ten weeks during the fall semester of 1989, the students in the treatment condition participated in the AT&T Learning Network. As participants in this Learning Network, they collaborated on a project with students in six other locations around the country (New Jersey, Nebraska, Alaska, and California) and overseas (Germany and Japan). The seven groups of students and their teachers constituted a Learning Circle, a group of individuals connected by means of an electronic network and dedicated to collaborating on a project of mutual interest. This Learning Circle's project involved the writing and publication of a booklet about life in the various locations represented by the members of the Learning Circle. The students would interact electronically with their Learning Circle peers throughout the country and the world, asking and answering questions about the lives of adolescents in Germany, Nebraska, Alaska, etc. The students in the treatment condition wrote essays about their own lives and sent their essays to all of the members of their Learning Circle. Eventually, a select group of students and teachers in the Learning Circle culled the available student writings and compiled

a booklet of the best or most interesting pieces.

In the process of writing their contributions to the booklet, the students in the treatment condition wrote initial drafts of their essays by hand, revised and edited those drafts, and entered their final essays into the computer so that they could be sent over the wire to the other locations in their Learning Circle. Because these students had limited access to the computers (about one day a week) much of their work went on as usual in their classroom, with the exception of those days they keyed their essays into the computer or received mail from the other members of their Learning Circle. In addition to being networked with the six other classes around the country and world, the computers used by these students in the computer lab were also networked, allowing the students in these special writing classes to send their writings and messages back and forth to each other. This researcher, however, saw no evidence that this in-house network was being used widely by the students.

The students in the control condition did not participate in the collaborative project and did not have access to the computers over the course of the fall semester. Like their peers in the treatment condition, however, they studied about other places across the country and around the world. Rather than acquiring information about these other places by interacting electronically with students who actually live in those places, the students in the control condition did traditional research on their chosen topics, primarily using encyclopedias and library books for their

information. Ultimately, the students in the control condition were required to write essays comparing some facet of life in the place they researched to life in upstate New York. While writing these essays, the students were encouraged to revise and edit their work and to share it with their peers to get constructive feedback. At the end of the semester, the teacher compiled the students' essays into a booklet. The teacher, the same for both conditions, attempted to use the same theories of writing instruction to guide her practice with both groups.

Essay Topics

Each student wrote an essay in September before work with the computer network system was operating and again in January after work with the computer network system was completed. The topic for the September assignment was to write an essay for a group of students from Florida who were planning to visit upstate New York, telling them what it is like to live in upstate New York. The January essay was the same, except the group of the students was supposed to be from California.

Instrumentation: Independent Variables

Linguistic self-efficacy. A measure of the students' self-perceptions of linguistic efficacy (or competence) was chosen as one of the student characteristic variables. Because self-perceptions of efficacy have been found to be strongly related to both actual competence and continuing motivation, this single variable should help illustrate how students of differing abilities and attitudes with respect to school based language tasks will

respond to the introduction of a computer network in their composition classroom. The students' self-perceived linguistic efficacy was determined with a paper-and-pencil, self-report instrument. This measure was modeled on instruments used by Bandura (1982) to asses individuals' self-efficacy for a wide range of tasks. The students were asked to indicate, by means of a percentile score ranging from 0 to 100, how confident they were that they could complete successfully a variety of school-based tasks demanding some degree of linguistic competence. The level of success was designated as receiving a grade of 'B' or better on those school-based tasks (e.g., "Can you write an essay describing your favorite place, which would receive a 'B' or better?" or "After reading a chapter in your textbook, can you write an essay that explains why you agree or disagree with the main idea of the chapter, which would receive a 'B' or better?").

The reliability of the instrument was estimated by means of a split half procedure. The instrument consisted of five pairs of items. A pair was two separate questions worded differently, but designed to assess the students' efficacy for the same task. Separate scores were calculated for each half of the test and then correlated. The correlation coefficient for the two halves of the measure for linguistic self-efficacy was .94.

Computer efficacy. Because students who are highly computer anxious may be less likely than their peers who are comfortable with computers to take advantage of a computer network when it is available, a measure of the students' self-perceptions of efficacy

for using computers was also included in the design of this study. The students' self-perceived computer efficacy was determined by means of a paper-and-pencil, self-report instrument, modeled on instruments used by Bandura (1986) to measure self-efficacy in a wide range of situations. The students were asked to indicate, by means of a percentile score ranging from 0 to 100, how confident they were that they could perform tasks with a computer (e.g., "Can you open up a file stored on a floppy disk, edit it, and save your edits?" or "Can you send a message to another person through computer mail?"). Before answering the questions, the students were told to assume that they had access to all of the computer equipment needed to complete each task.

The reliability of this instrument was estimated by means of the same split-half procedure used for the linguistic self-efficacy measure. The correlation coefficient for the two halves of the measure for computer self-efficacy was .96.

Instrumentation: Dependent Variables

Essay gain scores. Each student's essays were holistically scored by two raters. The two raters used a sorting procedure to score the essays. First, each reader read the entire group of essays, blind to the pre- and post-treatment conditions under which individual essays were written. Then, each reader read the essays again, dividing them into three piles--low, middle, and high. Then, each reader read the papers in the low pile and divided them into two more piles, low and high. The same was then carried out for the middle and high piles. Thus, the readers ended up with six

piles of papers ranging from very low, receiving a score of 1, to very high, receiving a score of 6. The two raters' scores for each paper were combined into a single score, ranging from 2 to 12. Finally, a gain score was calculated for each student by subtracting the student's score for the fall essay from his or her score for the spring essay.

Recalled Collaboration. A measure of the degree to which the students recalled collaborating on their writing assignments over the course of the semester was collected in January. The students were give a list of ten collaborative behaviors typical of student writers in classrooms that encourage collaboration (e.g., "Reading another student's paper," "Explaining a punctuation rule to another student," and "Borrowing an idea or fact from another student") . The students simply checked off each behavior they could recall engaging in over the course of the semester. The reliability of this measure was estimated by means of the same split-half procedure used for the efficacy measures. The correlation coefficient for the two halves of the collaboration measure was .77, while the Spearman-Brown formula for the measure was .94.

Class Rating. In January, the students were also asked to rate the quality of their special writing class, with 10 being the very best class they had ever taken and 1 being the very worst.

Analyses

The data were analyzed by means of three regression analyses. Three independent variables and two interaction terms were entered into the regression equation in the following order: the dummy

variable for treatment condition (computer network vs. no computer network), linguistic self-efficacy, computer self-efficacy, treatment condition x linguistic self-efficacy, and treatment condition x computer self-efficacy. The three outcome variables predicted by the three regression equations were the students' gain score for the quality of their September and January essays, the students' recollection of collaborating with peers over the course of the semester, and the students' rating of the quality of the course at the end of the semester.

RESULTS

Table 1 presents the intercorrelations of all independent and dependent variables in this study, as well as the means and standard deviations for these variables. Results of the regression analyses on the three dependent variables (quality of essay gain score, recalled collaboration, and class rating) are presented in Table 2.

For the regression on essay gain score, there is a significant main effect for treatment condition ($t = 3.79$, $p < .01$) and a significant interaction between treatment condition and linguistic self-efficacy ($t = -3.02$, $p = .01$). While students in the computer networked classes generally had the greatest gains in the quality of their writing, the significant interaction reveals a more complex picture of the situation. Figure 1 depicts the interaction between treatment condition and linguistic self-efficacy. Because of the relatively strong correlation between these two independent variables (Table 1, $r = .523$), the regression lines are highly

unstable and cannot be trusted. The plot of individual points, however, with "c" indicating a person in the computer network group and "nc" indicating a person in the no computer (or control) group, does provide a more reliable picture of the interaction.

As was expected, students reporting relatively low levels of linguistic competence in the no computer group had lower gain scores, showing no improvement or actually writing worse papers at the end of the semester, than did the one student in the no computer group who reported a relatively high level of linguistic competence. The opposite pattern was evident in the computer networked group. Students reporting lower levels of linguistic self-efficacy posted the greatest gains in their essay scores. Indeed, their gains were larger than the gains of their high linguistic slef-efficacy peers in the computer networked group and larger than the gains of those students reporting similar levels of linguistic self-efficacy in the no computer group.

The second regression analysis, with recalled collaboration as the predicted outcome variable, resulted in a significant main effect for computer slef-efficacy ($t = -4.32$, $p < .01$) and a significant interaction between treatment condition and computer self-efficacy ($t = 3.57$, $p = .01$). While the main effect for computer self-efficacy suggests that students with low levels of computer self-efficacy recalled more collaborative behaviors while working on their writing assignments than did their peers reporting high levels of computer self-efficacy, the interaction between treatment condition and computer self-efficacy, depicted in Figure

2, suggests the picture is not that simple. As was the case with the interaction reported for essay gain scores, the regression lines in Figure 2 are not reliable due to the relatively strong correlation between the two independent variables involved in this interaction (Table 2, $\underline{r}$ = .323). The individual plotted point, however, do provide a more reliable picture of the interaction.

For those individuals in the no computer group, high levels of computer self-efficacy were related to low levels of recalled collaboration and low levels of computer self-efficacy were related to high levels of recalled collaboration. This pattern is the one suggested by the significant main effect on recalled collaboration. For individuals in the computer networked group, however, high levels of computer self-efficacy were just as likely to be related to high levels of recalled collaboration as low levels of computer efficacy. In other words, with the introduction of the computer network, all students seem to be equally likely to recall collaborating with their peers while writing.

The third, and final, regression with class rating as the predicted outcome variable resulted in no significant effects for the three independent variables and the two interaction terms (Table 2).

DISCUSSION

While the small sample size and non-random assignment of individuals to the treatment conditions make the results of this study very tentative, they deserve attention because they are consistent with the findings of the much larger and better

controlled study conducted by Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, and Zubrow (1991). In both studies, the students who appear to have benefitted most from the introduction of the networked computer were those who were relatively less confident of their ability to use language effectively and those who were relatively more confident of their ability to use computers effectively.

For both of the significant interactions in this study, the students in the no computer or control group looked typical, what we would have expected them to look like. In the case of the treatment condition by linguistic self-efficacy interaction, students in the no computer group who reported relatively low levels of linguistic self-efficacy did not show improvement in their writing over the course of the semester. Many of them even wrote worse papers at the end of the semester than they did at the beginning of the semester. In contrast, the single student in the no computer group who reported a high level of linguistic self-efficacy showed a slight improvement from the first to second essay. We would expect students who lacked confidence in themselves with respect to their academic writing and reading tasks to improve less than their peers who were more confident of their linguistic abilities. This expected pattern did not, however, hold up for the students in the computer network group. In that group, the students reporting relatively low levels of linguistic self-efficacy were the ones who made the most dramatic gains in their essay scores, the largest gains of any students in the study.

Students reporting high levels of linguistic self-efficacy, in contrast, made slight gains in their essay scores, gains that seem reasonable and expected for one semester of remedial work aimed at improving their writing ability but that were in no way comparable to the gains of their peers in the computer group reporting low levels of linguistic self-efficacy.

In the case of the treatment condition by computer self-efficacy interaction, the students in the no computer group who reported high levels of computer efficacy recalled engaging in fewer collaborative behaviors than did their peers reporting lower levels of computer self-efficacy. This trend in the data was also not surprising as it seems consistent with the common stereotype of frequent users of computers as being people who are less socially oriented than their peers. In other words, high school students who spend a lot of time learning to use computers effectively might have less time or be less inclined to spend time developing the social skills that would translate to effective collaboration with peers over academic tasks. In the classes working with the networked computers, however, students reporting high levels of computer self-efficacy seemed no different than their low computer self-efficacy peers, recalling just as many collaborative writing behaviors as did their peers reporting low levels of computer self-efficacy. These students, who under normal conditions may be reserved and asocial, may feel more confident and be more likely to interact with their peers when computers are an integral part of their working environment.

Conclusion

The results of this study, taken in conjunction with the Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, and Zubrow (1991) study, suggest that the benefits of introducing network technologies in composition classrooms may be greatest for those students who have traditionally fared poorly in those classrooms. Perhaps computer networks do, indeed, provide less socially oriented and less academically skilled students with increased opportunities to interact with and learn from their teachers and peers. This new technology, in other words, may be especially well suited to the elusive task of creating a more equitable educational system, one in which all students interact freely and comfortably with their teachers and peers, thereby increasing their opportunities to learn and grow.

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Table 1

Intercorrelation Matrix, means, standard deviations: All variables

	Independent Variables			Dependent Variables		
	Treat. Cond.	Ling. Eff.	Comp. Eff.	Essay Gain	Colla-boration	Class Rating
Treat. Cond.	--					
Ling. Eff.	.523	--				
Comp. Eff.	.323	.325	--			
Essay Gain	.622	.063	.223	--		
Colla-boration	.437	.226	-.248	.140	--	
Class Rating	.057	.491	.046	-.289	.261	--
$\overline{X}$	.467	63.467	49.533	.600	6.667	5.267
SD	.516	20.035	32.663	3.291	2.637	2.738

Table 2

Summary of Regression Analyses

	Coefficient	Standard Error	t	p
Dependent Variable: Essay Gain				
INTERCEPT	-1.977			
Treat. Cond.	18.585	4.899	3.79	.00
Ling. Eff.	0.003	0.040	0.08	.94
Comp. Eff.	0.014	0.026	0.53	.61
Treat. x Ling. Eff.	-0.228	0.076	-3.02	.01
Treat. x Comp. Eff.	0.032	0.039	0.83	.43
Dependent Variable: Collaboration				
INTERCEPT	9.532			
Treat. Cond.	-0.938	3.931	-0.24	.82
Ling. Eff.	-0.007	0.032	-0.20	.85
Comp. Eff.	-0.089	0.021	-4.32	.00
Treat. x Ling. Eff.	-0.022	0.061	-0.36	.73
Treat. x Comp. Eff.	0.112	0.031	3.57	.01
Dependent Variable: Class Rating				
INTERCEPT	2.138			
Treat. Cond.	-4.176	6.514	-0.64	.54
Ling. Eff.	0.075	0.054	1.40	.19
Comp. Eff.	-0.027	0.034	-0.78	.45
Treat. x Ling. Eff.	0.017	0.100	0.17	.87
Treat. x Comp. Eff.	0.038	0.052	0.72	.49

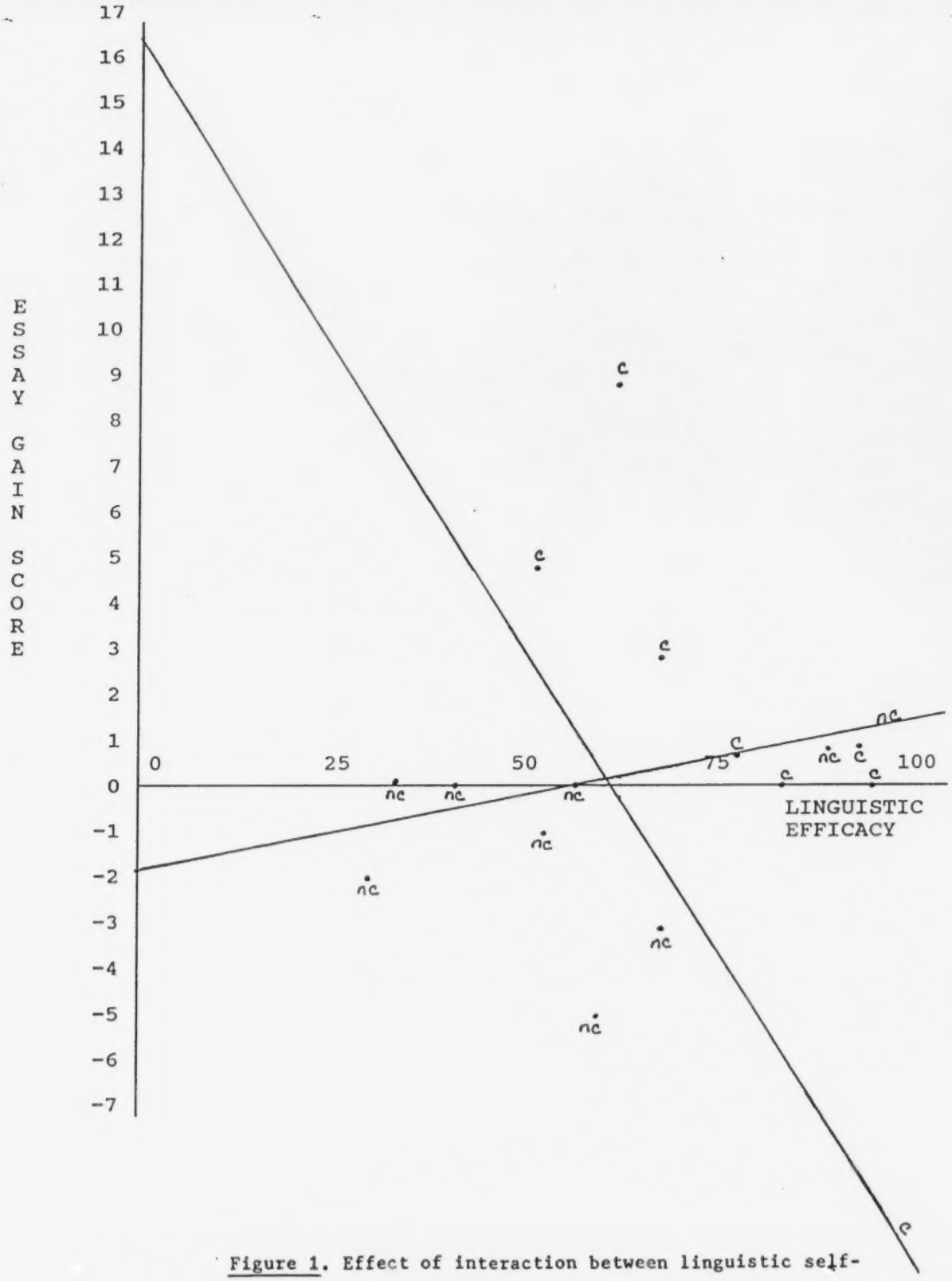

Figure 1. Effect of interaction between linguistic self-efficacy and treatment condition on students' essay gain scores. (c = computer group; nc = no computer group)

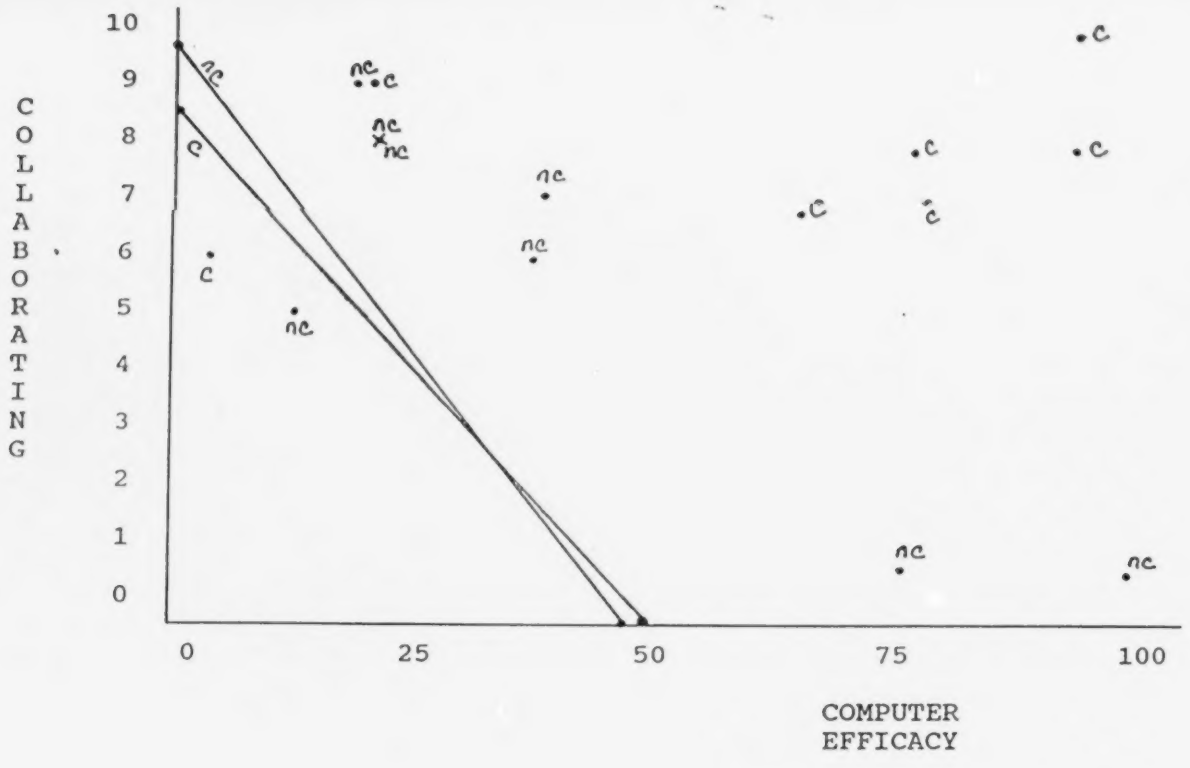

Figure 2. Effect of interaction between computer self-efficacy and treatment condition (c = computer group, nc = no computer group) on students' recollections of collaborative behaviors while writing.